Final result from the Mainz Neutrino Mass Experiment

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The most direct way to get information on neutrino masses is the investigation of nuclear-β-decay. Tritium is a good candidate due to its high specific activity and low endpoint energy. In Mainz the β-spectrum from a quench condensed, molecular tritium source is investigated close to its endpoint, in order to extract the rest mass of the electron antineutrino. The measurements are performed with a MAC-E-Filter, combining Magnetic Adiabatic Collimation and an Electrostatic high pass filter at a filter width of $\Delta E = 4.8$ eV. After an improvement program in 1997 data have been taken for running periods of 3 to 4 month per year (till 2001). Combining data from 1998, 1999 and 2001 the result of the standard analysis is:
$m_\nu^2 = -1.2 \pm 2.2 \pm 2.1$ eV^2/c^4 corresponding to $m_\nu \leq 2.2$ eV/c^2 (95% c.l.).
For this analysis only the last 70 eV of the β-spectrum have been taken into account. For such an interval the sum of statistical and systematic uncertainties obtains a minimum. One weak point in treating the systematic effects was, that the amplitude of neighbour excitation was taken from theory with only one calculation available. An alternative analysis of the whole data set, including the amplitude of the neighbour excitation in selfconsistent way, lead to a slightly more positiv result of:
$m_\nu^2 = -0.7 \pm 2.2 \pm 2.1$ eV^2/c^4 corresponding to $m_\nu \leq 2.3$ eV/c^2 (95% c.l.).
A significant step like anomaly in the integral β-spectrum close to the endpoint, the so called "Troitsk anomaly", has been observed only in one out of 12 data sets. Thus the effect is likely to be an instrumental artefact, rather than a physics phenomenon. To clarify the nature of the effect it was decided in 2000 to run the spectrometers in Troitsk and Mainz in parallel. Due to technical problems in Troitsk the overlap was only 2 times one week in december 2000. Step like anomalies showed up in the Troitsk data, but clearly not in the Mainz data.
The Mainz Experiment has reached its sensitivity limit and was modified in 2002 to investigate background issues as preparation for a new larger experiment KATRIN. The KArlsruhe TRItium Neutrino Experiment will be settled at the Forschunszentrum Karlsruhe and will cover fully the cosmologically relevant parameter space down to the sub-eV-range.